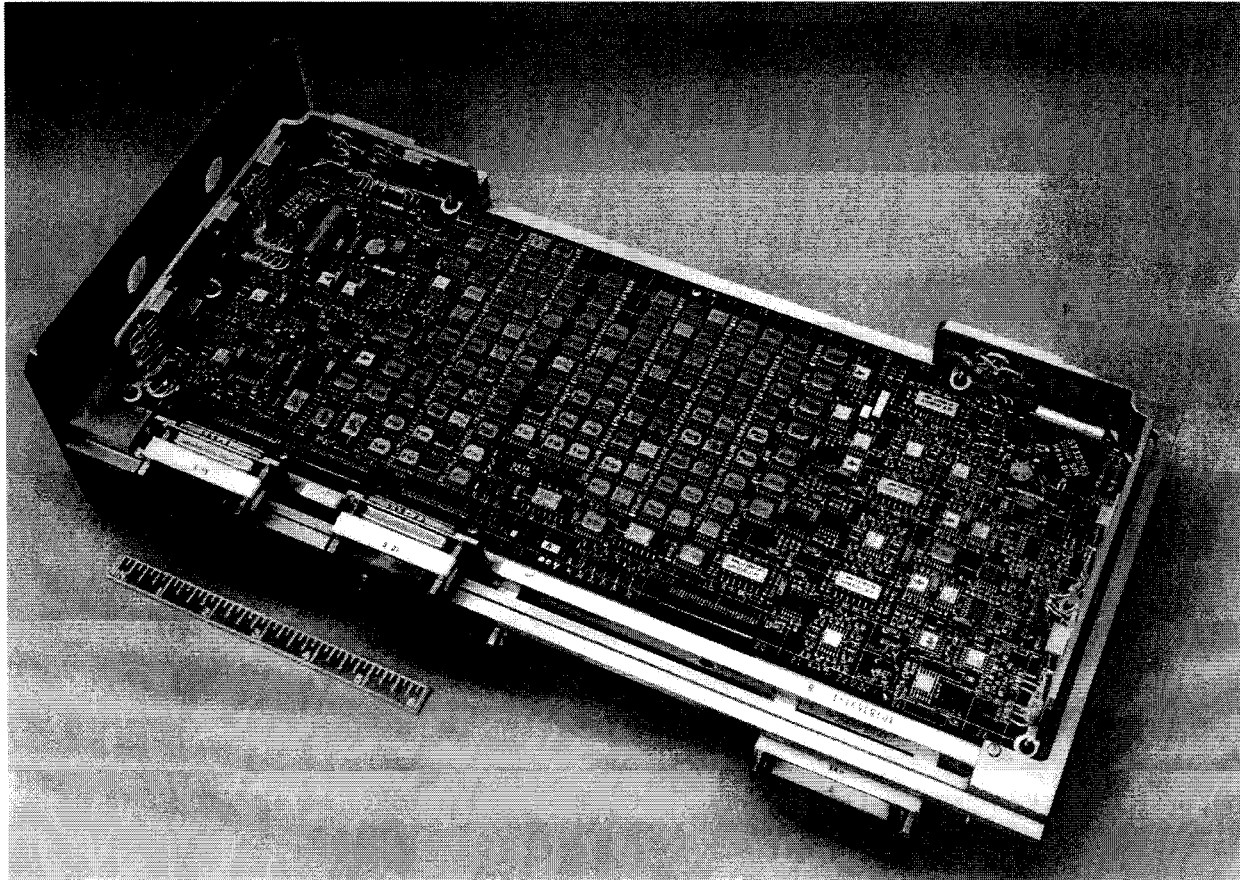


Lessons Learned in Outsourcing of Board Assemblies

Charles Bodie-Electronic Packaging and Fabrication Section
Jet Propulsion Laboratory
Pasadena, California

Electronic Assembly Fabrication



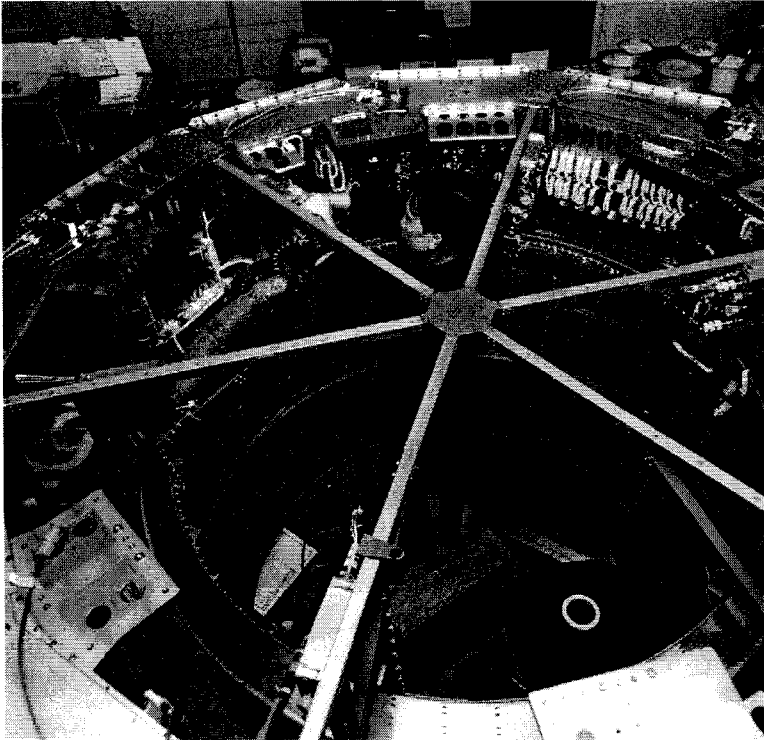
Jet Propulsion Laboratory



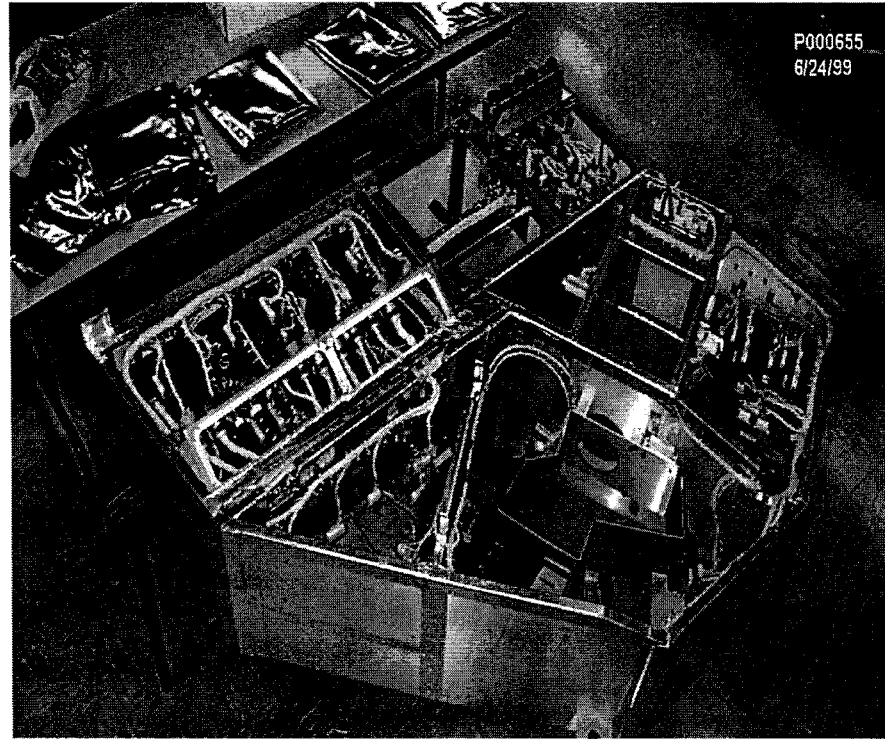
156 Acres, 133 Buildings, 73 Trailers, 5500 Employees

Principal Product-Solar System Exploration Spacecraft

Harness Fabrication



Cassini Ring Harness



Micro Wave Limb
Sounder (MLS)
Harness

Outsourcing Thrust

- NASA states that JPL must share the “pie” with industry and reduce internal staff.
- JPL to do what never has been done before. Let industry do what industry can do as well or better than JPL.
- Conventional Electronic Circuit Board assembly and Harness fabrication are to be outsourced.

New Environment

- Faster-Better-Cheaper
- Same budget spread over many more programs. Dilutes the pool of experienced seasoned veterans.
- Time from initiation to flight reduced
- Quality and reliability requirements and desires remain as high as ever
- Procurement regulations stiffened
- “Gray Beards” are retiring and Green Troops taking over.

Harnessing Experience

- JPL experience with the subcontracting of Spacecraft Harnessing has been excellent. Why?
 - ▼ Contractors specializing in harnessing of spacecraft are accustomed to first of a kind projects.
 - ▼ Minimum documentation required (Usually net list only)
 - ▼ Sheet metal mock-up is supplied by JPL
 - ▼ JPL sends technician as lead and JPL engineers visit often.
 - ▼ Parts are generally well know commodities (Connectors, wire, splices, etc.)
 - ▼ Tooling well defined

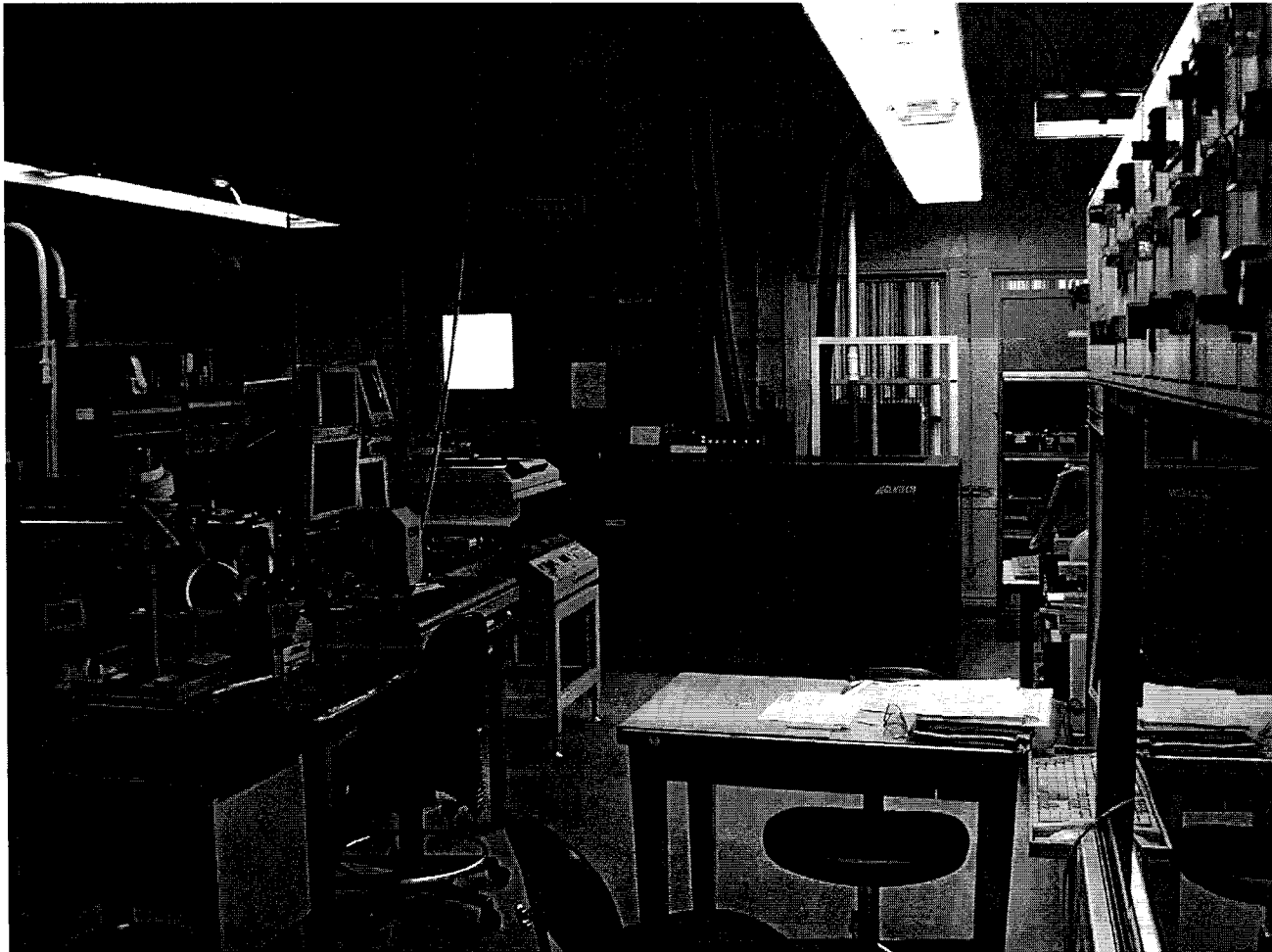
Results of Harness Outsourcing

- Reduction in JPL workforce.
- Those remaining are highly skilled which can handle emergency rework and modification in final assembly and at launch sites.
- Technicians have been re-trained to be contract manager assistants as well as technical interfaces.

PWBA Outsourcing

- Fast Paced Projects require speedy service (Cassini was 5-6 year program, Mars '03 will be less than 30 months)
- Always “first of a kind” work
- Extremely low volume
- Many part numbers but few of each required
- No relaxation of customer expectations

JPL SMT Laboratory



JPL Cultural Impediments

- First of a kind means immature design and, therefore, inadequate drawings.
- Many projects insist on doing it in-house to “have control”
- Everyone gets into the act
- Engineers never quit engineering
- Entrepreneurial spirit allows individuals to do their own thing

Business Impediments

- Companies which are qualified for space work are busy
- Low volume means less interest on part of Industry
- Start-up costs are amortized over very small number of units
 - ▼ High Manufacturing engineering and tooling costs
 - ▼ Requirements are oppressive (900 pages of documents)
- Meetings and reviews are commensurate with the JPL interests and requirements
 - ▼ Kickoff Meeting
 - ▼ Ready to fabricate review
 - ▼ Ready to ship review

Technical Impediments

- Printed Wiring Board fabrication and test
 - ▼ JPL surveys PWB fabricators for in-house builds and monitors quality
 - ▼ Same fabricator may not supply same quality to Contractor
 - ▼ JPL insists on testing to net list not “golden board”
- Parts
 - ▼ JPL provides parts -Problems with lead forming, compatibility with contractor machines (e.g. Pick and Place)

Technical Impediments (cont.)

- ▼ Contractor provides parts- Long lead items cause schedule slips, many custom parts in new designs (ASICs, FPGAs)
- ▼ JPL part numbering not compatible with Contractor's inventory control system
- Tooling-
 - ▼ JPL will supply solder paste stencil if part made previously. Usually doesn't fit the Contractor's screen printer.
 - ▼ Lead forming dies needed to form leads to match PWB artwork. JPL will loan out if not in use.

Technical Impediments(cont)

- Bonding, Staking, conformal coating (Polymeric)
 - ▼ Materials must not outgas for vacuum environment near optics. If JPL supplies material, Hazard Material handling precautions and paperwork imposed.
 - ▼ Special bonding fixtures required
 - ▼ Special training required
 - ▼ Desirable to test at JPL prior to conformal coating
 - ▼ Result is that JPL does all polymerics application which requires additional level of drawing

Results of Outsourcing PWBA's

- Not very successful
- Frustrations for JPL and for prospective Contractors
- We are attempting to improve the process